(12) UK Patent Application (19) GB (11) 2 122 928 A

(21) Application No 8315112
(22) Date of filing 2 Jun 1983
(30) Priority data
(31) 8210979
(32) 23 Jun 1982
(33) France (FR)
(43) Application published
25 Jan 1984
(51) INT CL³
B23P 19/00
(52) Domestic classification
B3A 158
B3J 15
F2G 9K 9N
U1S 1968 1969 B3A B3J
F2G
(56) Documents cited
None
(58) Field of search
B3A
(71) Applicant
Valeo
(France),
64 Avenue de la Grand
Armee, 75017 Paris,
France
(72) Inventor
Denis Villeval
(74) Agent and/or Address for
Service
Page White and Farrer,
5 Plough Place, New
Fetter Lane, London
EC4A 1HY

(54) **Method of assembling at least one tube on a plate and equipment for performing this method**

(57) A tube (11) is assembled on a plate (16) with the inter position of a seal element (17). The plate and the seal element both have a hole and the hole of the seal element is provided with a collar (21). The seal element is located in the hole in the plate and one end of the tube is inserted into the collar. The method of assembly includes the step that, before the tube is inserted into the collar, the collar is prestressed by subjecting it to a radial reduction of its thickness in abutment with the hole of the plate, so as to permit insertion of the tube into the collar.

FIG.3

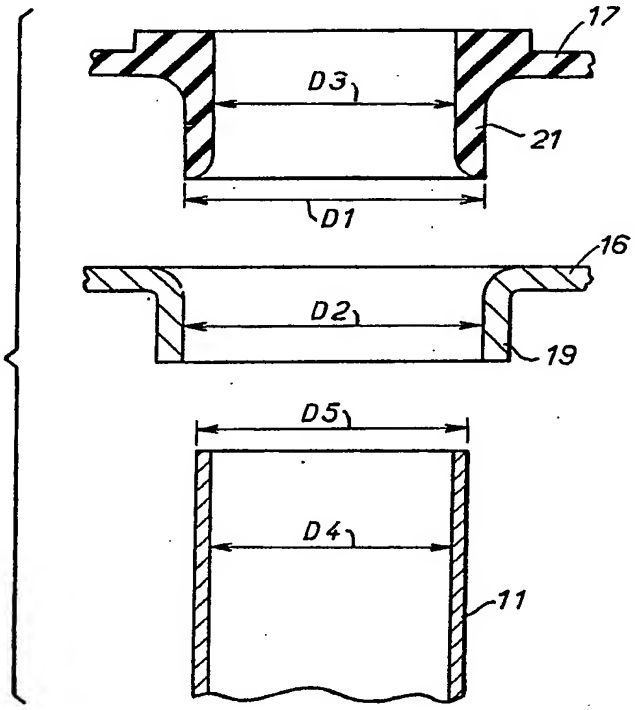
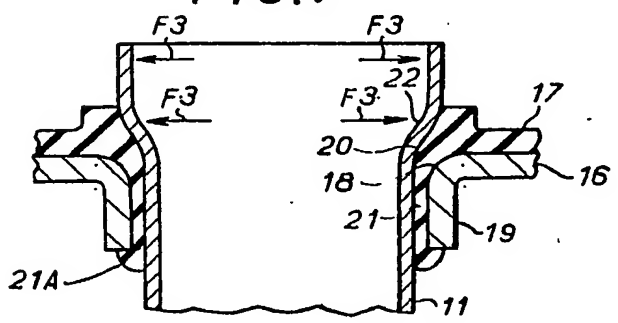


FIG.7



GB 2 122 928 A

FIG. 1

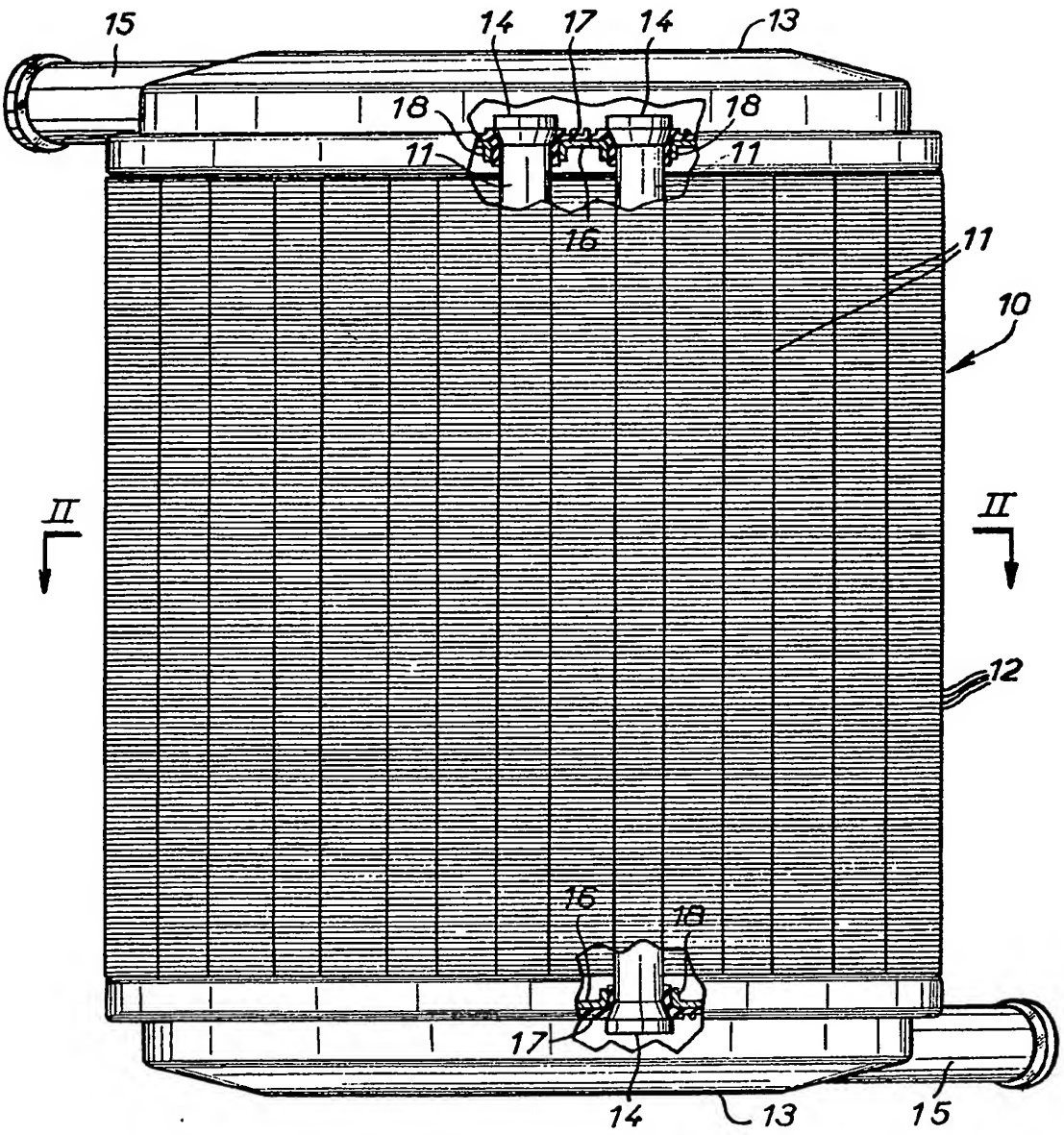


FIG. 2

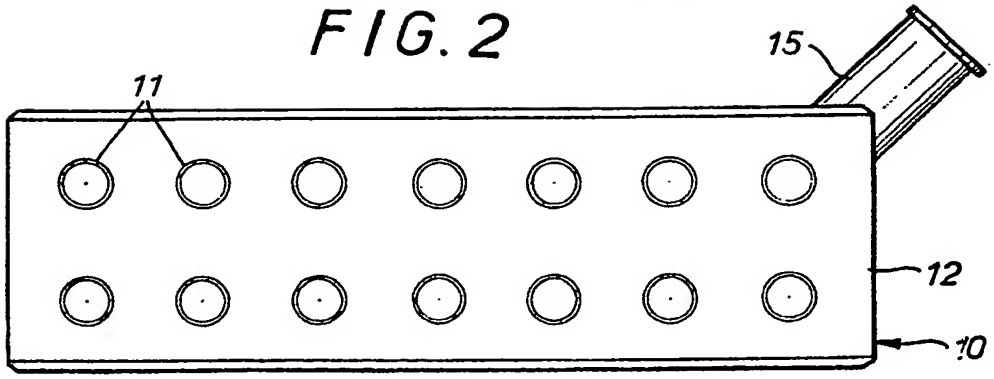


FIG.3

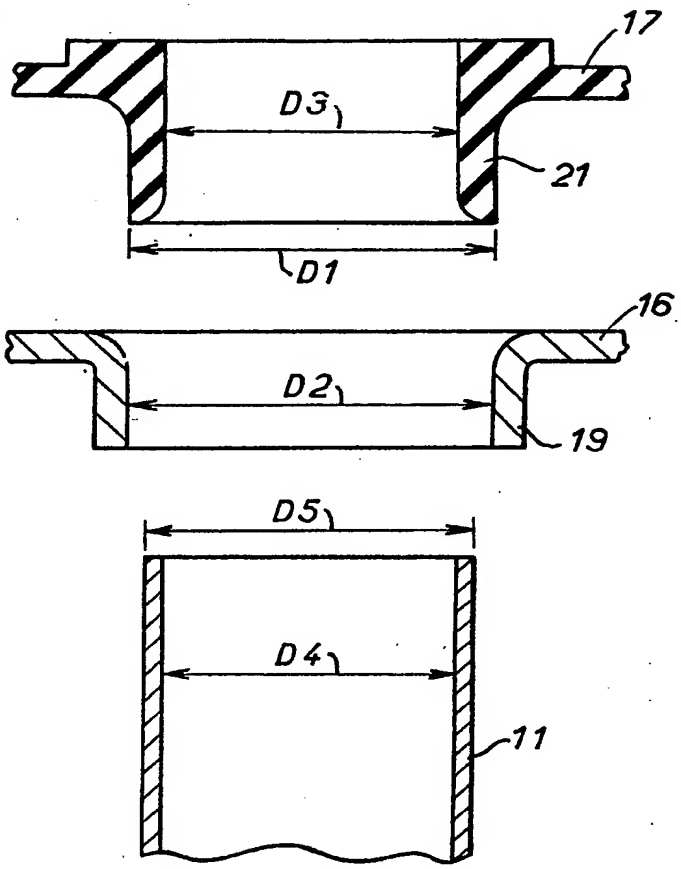


FIG.4

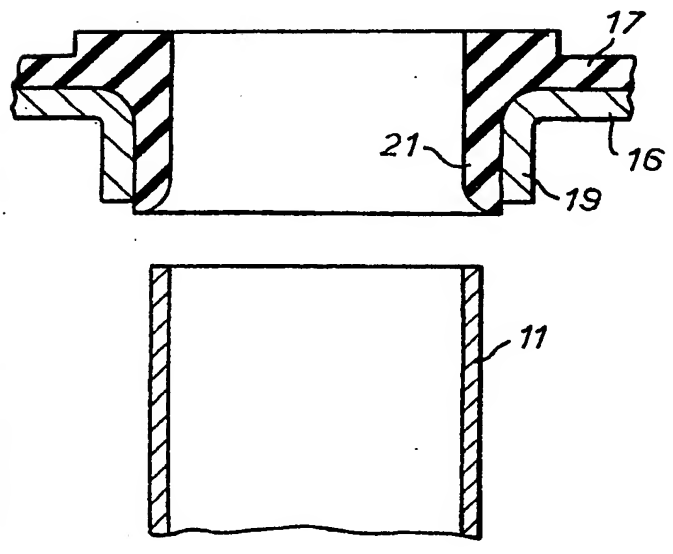


FIG.5

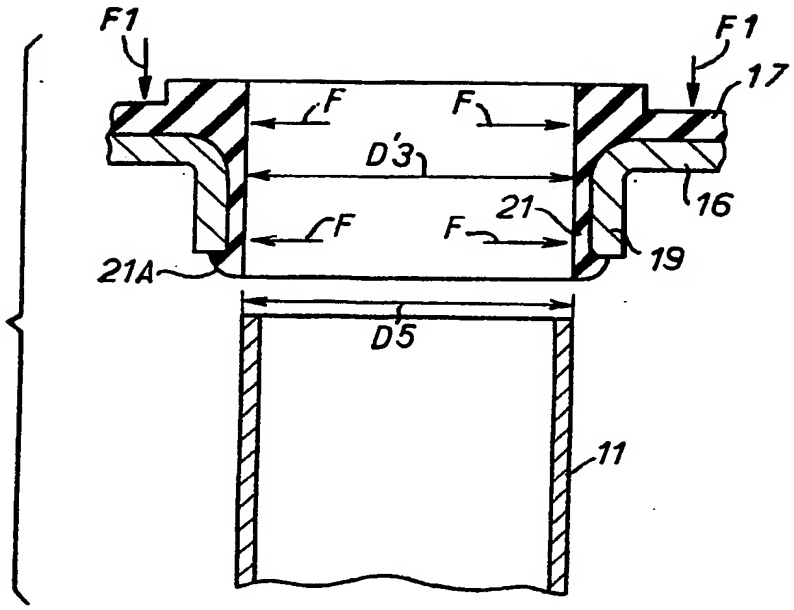


FIG.6

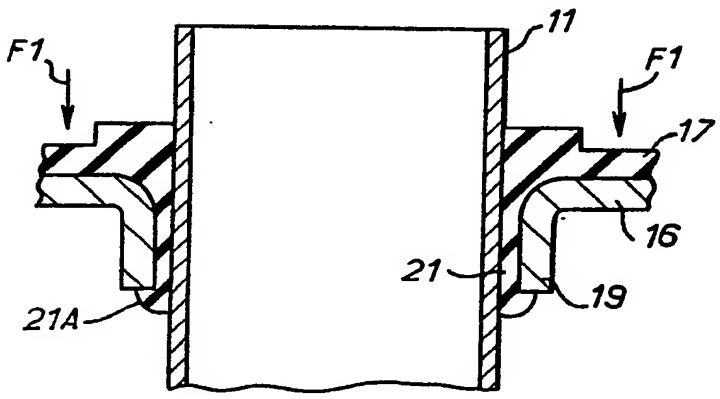
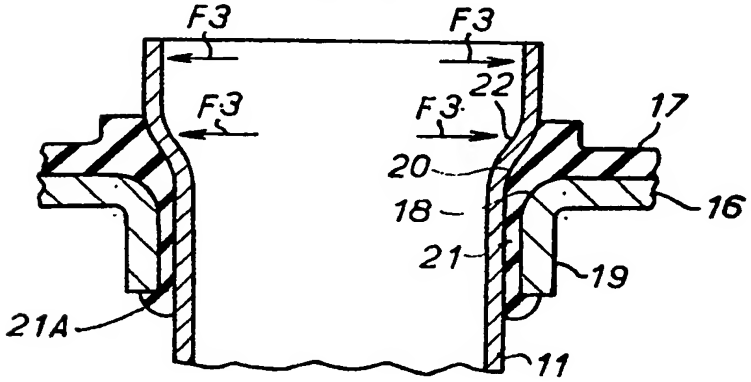


FIG.7



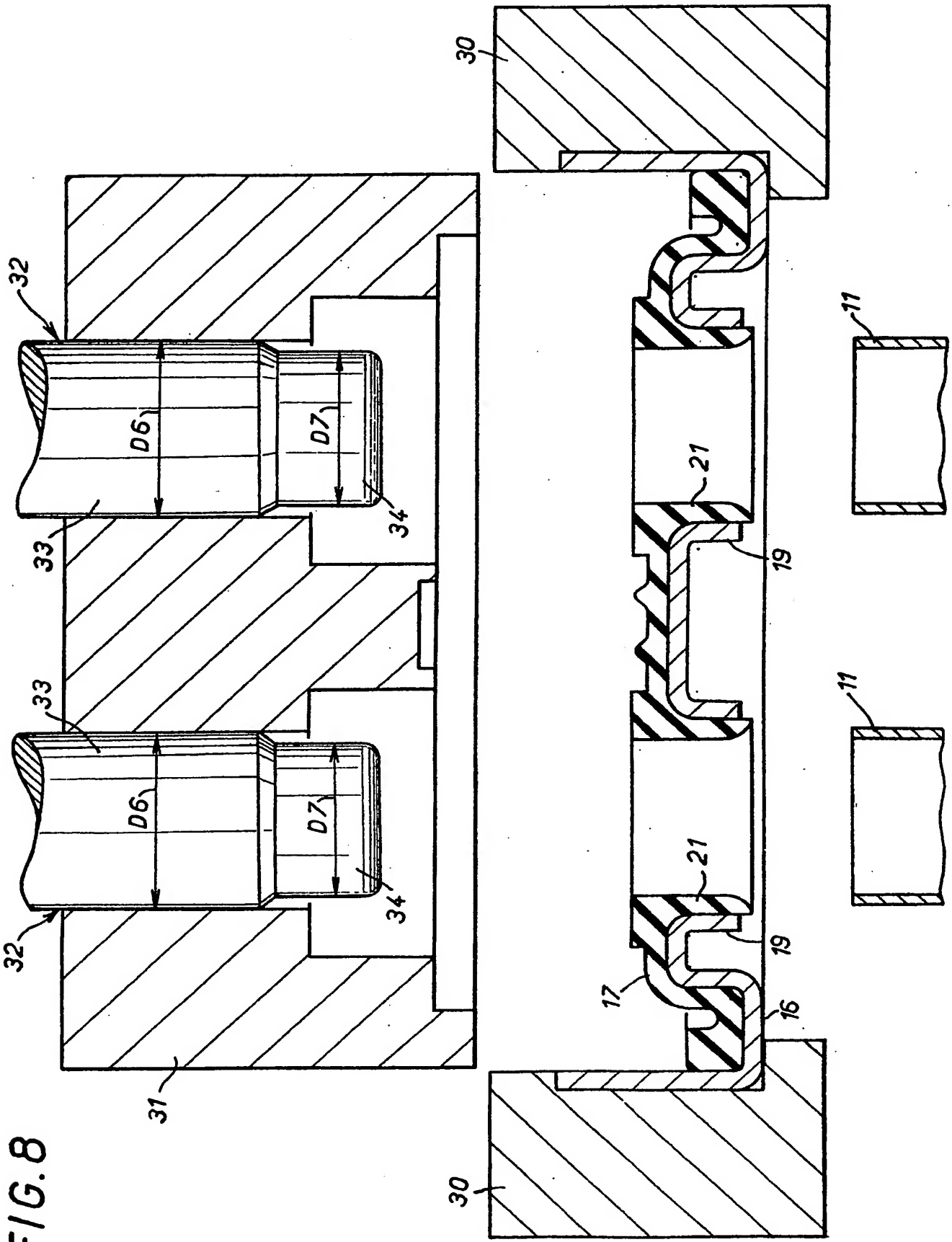


FIG.8

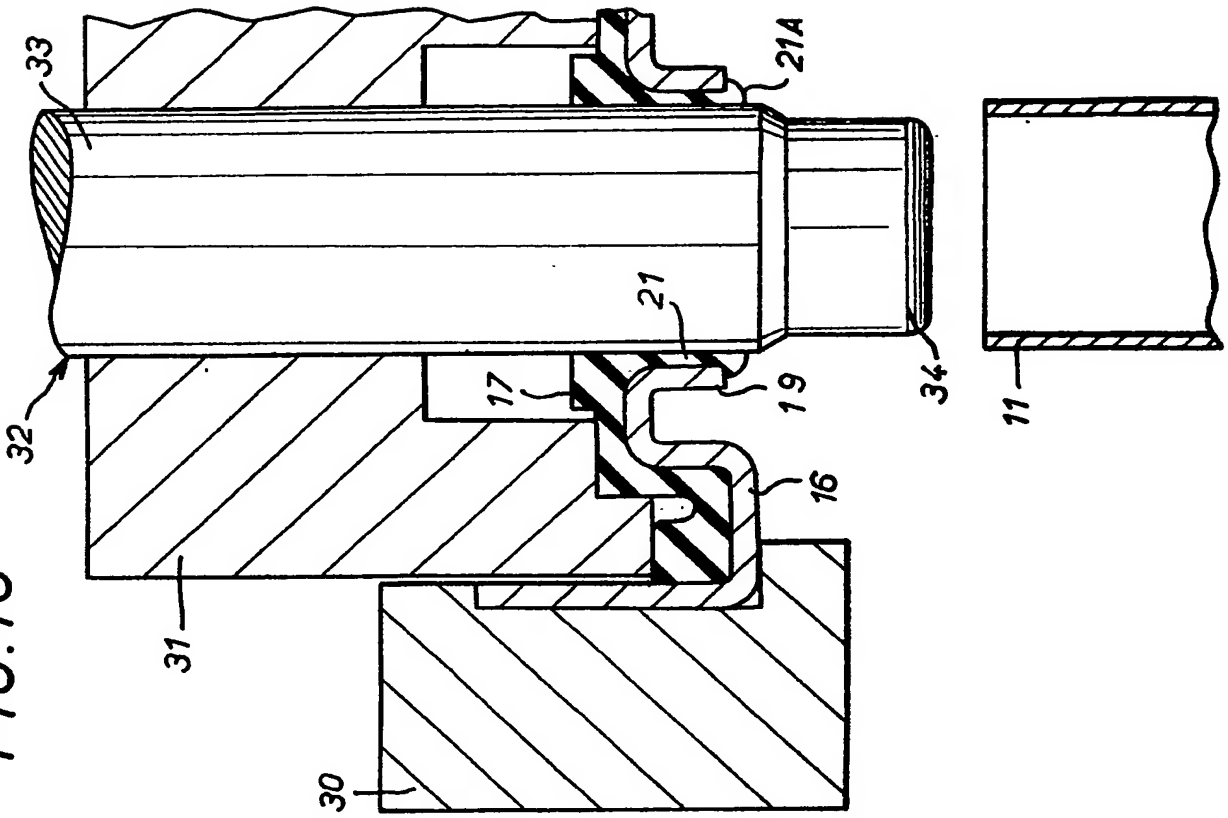


FIG.10

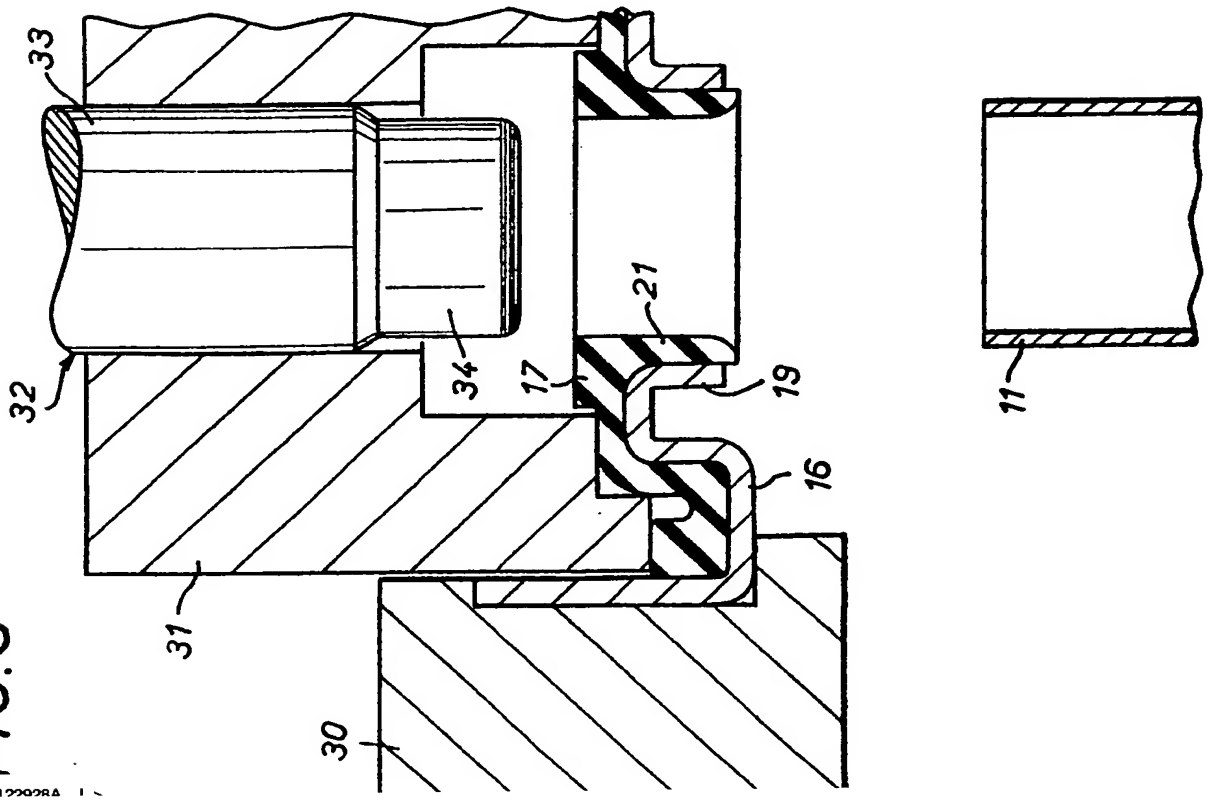


FIG.9

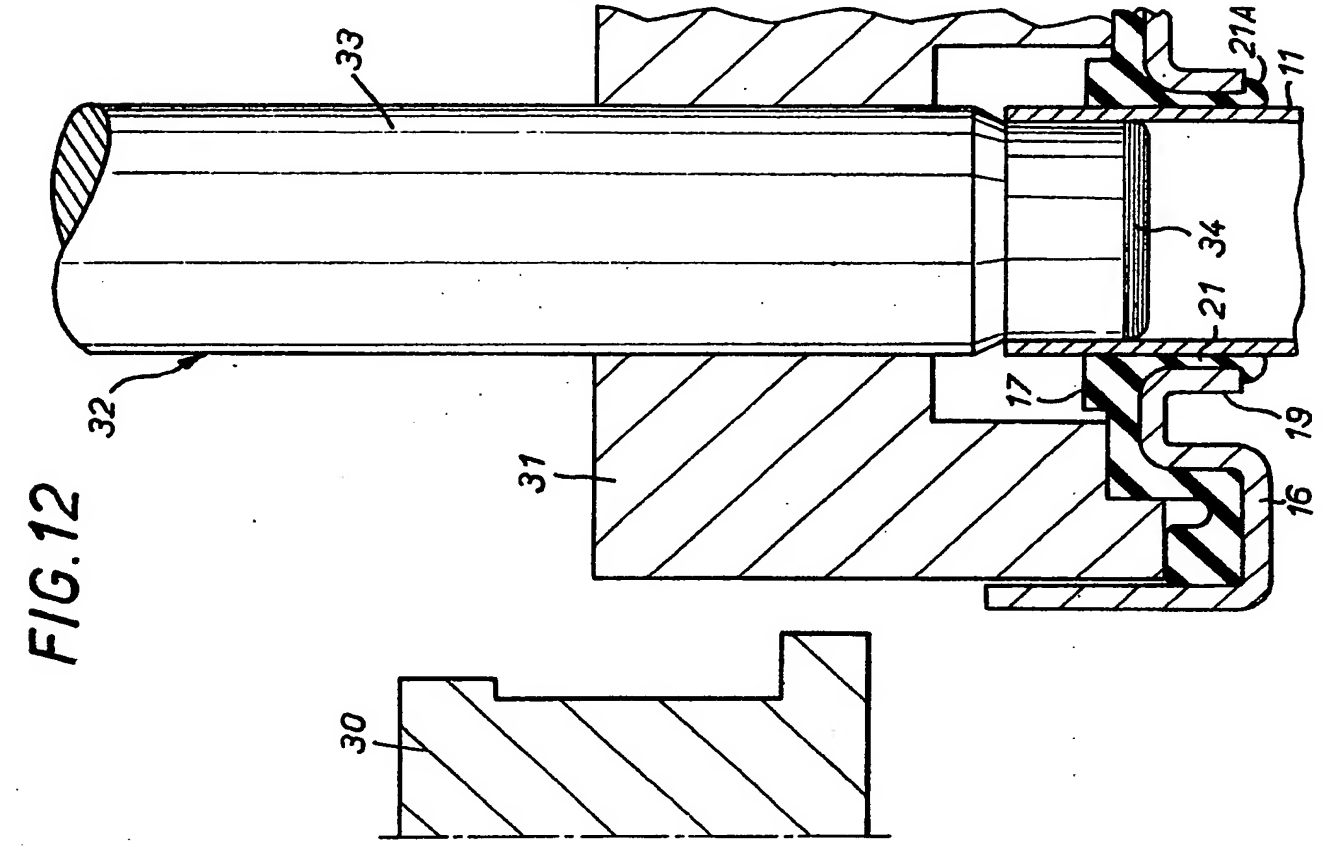


FIG.12

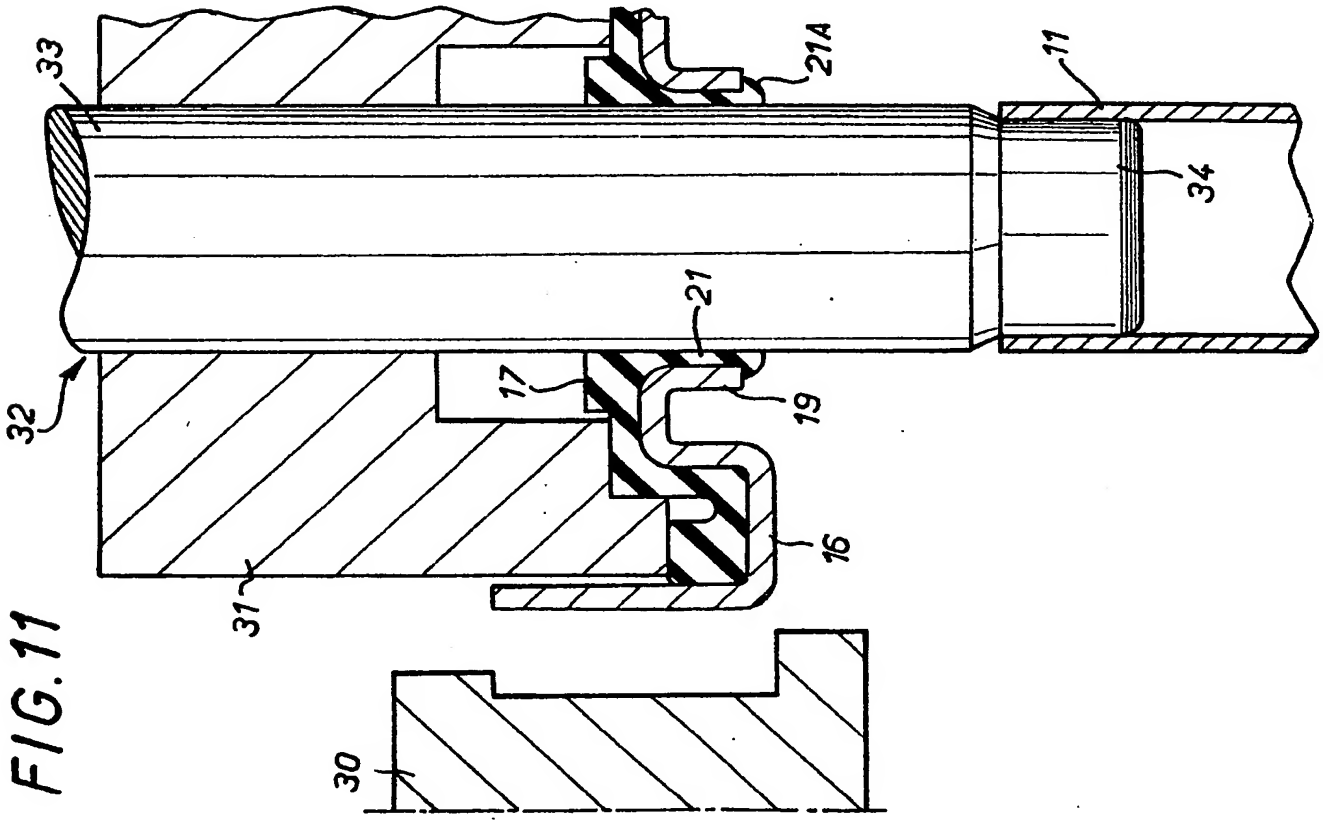
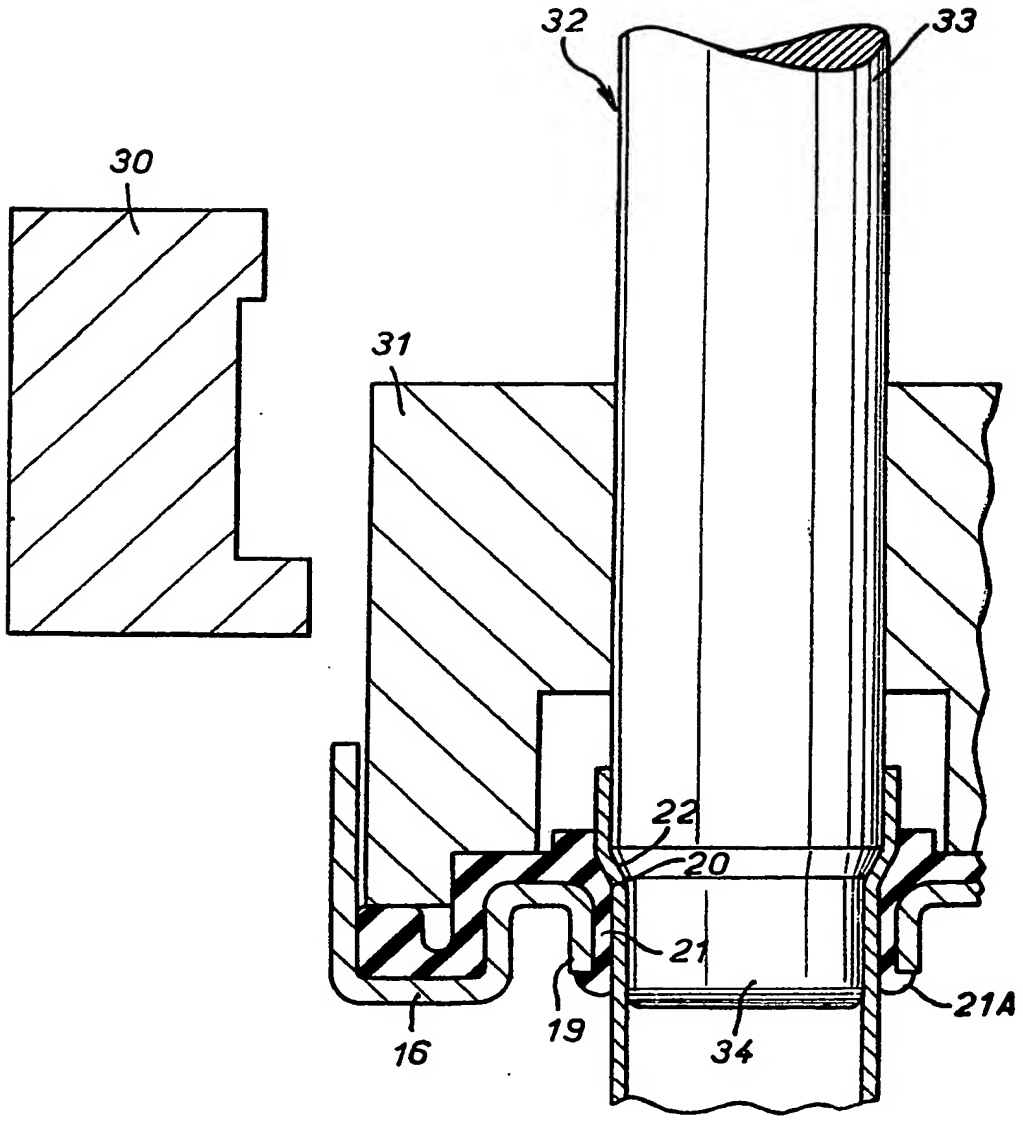


FIG.11

FIG. 13



SPECIFICATION

Method of assembling at least one tube on a plate, and equipment for performing this method

This invention relates to a method of assembling, particularly for a motor vehicle heat exchanger, at least one tube on a plate with interposition of a seal element, the plate and the seal element each having at least one hole, the hole of the seal element being provided with a collar, one end of the tube being inserted into the collar of the seal element which is itself located in the hole of the plate, said seal element providing fluid-tightness between the tube and the plate.

A method is known whereby the tube is first of all inserted into the hole of the seal element and is then deformed so as to present a cylindrical enlargement at the level of the collar of the seal element for the fluid-tight assembly of the tube and of the plate, but this *modus operandi* presents risks of rupture of such an assembly, particularly in the case where the tubes have already undergone a preliminary flaring.

A method is likewise known whereby the tube is inserted by force into the seal element, but such a procedure presents various disadvantages at present, particularly in complicated production necessitating the provision of particular shapes to facilitate the entry of the tube into the seal element. It also requires, the operation of and then the removal of various accessories. This is not conducive to mechanisation of the method, and in any case it involves risks of separation of the seal element from the plate at the time when the tube is inserted.

This invention relates to a method of assembling at least one tube on a plate lined with a seal element, which is simple and convenient and which is conducive to mechanisation if required.

According to the invention, this method is characterised in that, before inserting the tube, the collar of the seal element is prestressed by subjecting it to a radial reduction of its thickness in abutment with the hole of the plate; the inside diameter of the collar of the seal element being, before prestressing, smaller than the outside diameter of the tube and becoming, after prestressing, sufficiently enlarged to permit insertion of the tube into the collar of the seal element.

By virtue of this arrangement all the difficulties which might result from an insertion by force are avoided, but furthermore, the risks of separation of the seal element from the plate at the time when the tube is inserted, are avoided, since this insertion is made easy by the prestressing of the collar of the seal element, the diameter of which is sufficiently enlarged at the time when the tube is inserted for this insertion to be easy.

Furthermore, the prestressing of the collar of the seal element causes the formation of at least one bead on this element, which assists the attachment of the seal element to the plate and prevents any undesirable movement of said element relative to said plate during the introduction of the tube and in spite of the friction between the tube and the seal element at the time of insertion.

Thus excellent fluid-tightness is achieved on the one hand between the seal element and the tube, and on the other hand between the plate and the seal element, that is to say between the tube and the plate.

The method according to the invention is particularly applicable to the case where the plate and the seal element are provided with collars. Indeed the prestressing of the seal element produces an attachment between the two collars which, with the above-mentioned bead formation, still further prohibits any untimely movement of the seal element relative to the plate during the introduction of the tube.

According to another preferred feature of the invention, after the prestressing of the collar of the seal element, the collar of the seal element is transferred onto the tube, thereby maintaining it prestressed. All risks of difficult insertion of the tube into the collar of the seal element are thus avoided.

As a guide, the radial reduction in thickness of the collar of the seal element resulting from the prestressing is of the order of 30 to 70% and preferably nearly 50%. In this case, the prestressing has the effect of reducing by one half the wall thickness of the seal element, which permits excellent clamping on the tube and on the hole of the plate, resulting in faultless fluid-tightness.

The seal element may line the plate on either side, but preferably opposite the side through which the tube is inserted. In this case, the seal element is clamped against the plate whilst the hole of the seal element is prestressed.

The prestressing of the hole of the seal element may be effected by an appropriate means. Preferably, the hole of the seal element is prestressed by engaging axially into the hole of the seal element a punch having an active part, the outside diameter of which is equal to the required inside diameter of the collar of the seal element when prestressed. The punch is advantageously engaged into the collar of the seal element through the side opposite to that through which the tube is inserted.

According to another preferred feature of the invention, after the collar of the seal element is prestressed by the punch, and the tube has been inserted into the prestressed collar of the seal element, this same punch is engaged into the tube to form a mechanical retention flare of the tube, the outside diameter of the active part of the punch being equal to the required inside diameter of the tube at the position of the flare.

This flaring operation makes it possible to prevent the separation of all the tubes relative to the plate.

In a preferred embodiment, the active part of the punch is preceded by a centring part having a

smaller diameter than the active part. The diameter of the centring part of the punch is substantially equal to the inside diameter of the seal element before prestressing, itself substantially equal to the inside diameter of the tube before the tube is flared.

Thus the centring part of the punch permits a faultless engagement of the active part of the punch into the collar of the seal element for the prestressing of this collar, and likewise a faultless transfer of the prestressed collar of the seal element between the active part of the punch and the tube.

It should be noted that the seal elements may be formed by elements such as eyelets associated individually with the various respective holes of the plate, but they may likewise be grouped advantageously to form one or more diaphragms each associated with a plurality of holes of the plate, or all of these holes.

One aspect of the invention relates to equipment for performing the above-mentioned method.

This equipment comprises a bezel adapted to receive in abutment the plate lined with the seal element, an axially movable presser adapted to maintain the seal element clamped against the plate, itself in abutment with the bezel, and a punch fitted axially movably in the presser to prestress the collar of the seal element. According to another preferred feature of this equipment, the bezel is laterally retractable and the presser is adapted, by axially thrusting on the seal element and the plate, to transfer the prestressed collar of the seal element onto the tube. The punch is also advantageously adapted, by moving axially relative to the presser, to flare the tube.

This invention likewise relates to applications of the above-mentioned method and/or equipment, and particularly to a radiator, particularly for a motor vehicle, comprising a plurality of tubes, at least one end of which is assembled on an end plate of a water chamber; said plate being provided with a seal element.

This radiator is assembled on the plate by the above-mentioned method and/or by means of the above-mentioned equipment.

An embodiment of the invention is described below by way of example with reference to the accompanying drawings, wherein,

Figure 1 is a view in elevation, with partial fragmentations, of a motor vehicle radiator;

Figure 2 is a corresponding view of this radiator in section along II—II of Figure 1;

Figure 3 is a view on a larger scale showing details of the parts used in assembling the radiator;

Figure 4 is a view similar to Figure 3, but at a later stage in the assembly;

Figure 5 is a view similar to Figure 4, but at a later stage in the assembly;

Figure 6 is a view similar to Figure 5, but at a later stage in the assembly;

Figure 7 is a view similar to Figure 6 in which the assembly is complete;

Figure 8 shows the equipment for performing the method according to the invention;

Figure 9 is a similar view to Figure 8, but at a later stage of the assembly;

Figure 10 is a view similar to Figure 9, but at a later stage of the assembly;

Figure 11 is a view similar to Figure 10, but at a later stage in the assembly;

Figure 12 is a view similar to Figure 11, but at a later stage in the assembly; and

Figure 13 is a view similar to Figure 12, but at a later stage in the assembly.

In the embodiment illustrated in Figures 1 to 13, which relates, by way of a non-limiting example, to the application of the invention to a motor vehicle radiator for the assembly of the tubes of this radiator onto the water chambers, this radiator is shown at 10 in Figures 1 and 2.

The radiator 10 (Figures 1 and 2) comprises a plurality of fluid pipes 11 formed by a bank of parallel tubes. These tubes 11 are equipped with a stack of fins 12 spaced in close formation.

At each end of the tube bank 11, these tubes 11 are fixed to a water chamber 13, with which these tubes communicate at 14. Each water chamber 13 is equipped with a connection 15 for the purpose of the circulation of the fluid in the tubes 11 equipped with the fins 12 via the water chamber 13.

Each water chamber 13 comprises an end plate 16 of rigid material, lined with a seal diaphragm 17 of elastic material.

The plate 16 is equipped with a plurality of holes 18 equal in number to that of the tubes 11, that is to say fourteen in the example illustrated in Figure 2.

Each hole 18 of the plate 16 (see particularly Figure 7) is provided with a collar 19 oriented towards the inside of the radiator 10.

Similarly, the diaphragm 17 is provided with a plurality of holes 20 equal in number to that of the holes 18 of the plate 16, itself equal to the number of tubes 11, that is to say fourteen in the example illustrated in Figure 2. Each hole 20 of the seal diaphragm 17 is provided with a collar 21 oriented towards the inside of the radiator 10.

In the example illustrated in Figures 1 to 13, the seal diaphragm 17 lines the end plate 16 on the side of the latter which is oriented towards the outside of the radiator 10. The seal diaphragm 17 closely lines the plate 16 and each collar 21 of the seal diaphragm 17 is nested in a corresponding collar 19 of the plate 16.

The various pairs of nested collars 19 and 21 correspond, in plan, respectively to the various tubes 11 (Figure 2).

A tube 11 corresponding to a pair of nested collars 19 and 21 (Figure 7) is threaded by its corresponding end into the collar 21 of the diaphragm 17 itself nested into the collar 19 of the plate 16.

The tube 11 is preferably deformed so as to present at least one flare 22 in proximity of the collars 19 and 21 mutually nested for the assembly of tube 11 and of the plate 16 and for

the fluid-tightness both between the tube 11 and the diaphragm 17 and between the diaphragm 17 and the plate 16.

The assembly is performed in the following manner (Figures 3 to 7).

The end plate 16, the seal diaphragm 17 and the tube 11 are first of all completely mutually separated (Figure 3). The outside diameter D1 of the collar 21 of the seal diaphragm 17 is substantially equal to the inside diameter D2 of the collar 19 of the plate 16, so as to permit easy nesting of the collar 21 into the collar 19. The inside diameter D3 of the collar 21 is substantially equal to the inside diameter D4 of the tube 11, that is to say substantially smaller than the outside diameter D5 of this tube 11.

First of all the elastic diaphragm 17 is applied into contact with the plate 16, nesting the collars 21 into the collars 19. This nesting is easy, in view of the choice of the diameters D1 and D2 which has just been stated. The tube 11 is then ready to be threaded into the collar 21 nested into the collar 19, as shown in Figure 4.

However, before the tube 11 is threaded into the collar 21, this collar 21 is prestressed (Figure 5) by subjecting it to a radial reduction of its thickness in abutment with the collar 19 of the plate 16, so that the inside diameter D3 of the collar 21, after such prestressing, becomes enlarged to a value D'3 substantially equal to the outside diameter D5 of the tube 11, that is to say sufficient to permit an easy threading of the tube 11 into the collar 21 of the diaphragm 17. The prestressing of the collar 21 causes (Figure 5) the formation of at least one bead 21a, only one in the example illustrated, which assists the attachment of the diaphragm 17 to the plate 16.

As a guide, the radial reduction in thickness of the collar 21 of the diaphragm 17 resulting from the prestressing is of the order of 30 to 70% and, as illustrated, preferably nearly 50%.

After the collar 21 of the diaphragm 17 is prestressed, this collar 21 is transferred (Figure 6) onto the tube 11, maintaining the prestressing.

Preferably the elastic diaphragm 17 is clamped against the plate whilst the collar 21 of the diaphragm 17 is prestressed (Figure 5) and/or whilst this prestressed collar 21 is transferred onto the tube 11 (Figure 6).

This clamping is advantageously maintained both during the prestressing (Figure 5) and during the transfer (Figure 6).

The prestressing of the collar 21 of the elastic diaphragm 17 is illustrated by the arrows F in Figure 5, and the clamping of the diaphragm 17 by the arrows F1 in Figures 5 and 6.

After the tube is threaded into the collar 21 (Figure 6), the tube 11 may be deformed (Figure 7) so as to make it exhibit at least one flare, and preferably a single flare such as the flare 22 in proximity of the collars 19 and 21 to effect a mechanical joint between the tubes 11 and the plate 16 and for fluid-tightness both between the tube 11 and the diaphragm 17 and between the diaphragm 17 and the plate 16. Such a flaring operation is illustrated by the arrows F3 in Figure 7.

For the purpose of the assembly as has just been described with reference to Figures 3 to 7, it is advantageous to use an equipment such as illustrated in Figures 8 to 13, to which reference will now be made.

This equipment comprises a bezel 30 (Figures 8 to 13) adapted to receive in abutment the plate 16 lined with the diaphragm 17. The equipment likewise comprises an axially movable presser 31 adapted to maintain the diaphragm 17 clamped against the plate 16, itself in abutment with the bezel 30. The equipment also comprises a punch 32 fitted axially movably in the pressure 31 to prestress the collar 21 of the diaphragm 17.

The bezel 30 is laterally retractable (Figures 11 to 13) and the presser 31 is adapted, by axially thrusting the diaphragm and the plate, to transfer (Figure 12) the prestressed collar 21 of the diaphragm 17 onto the tube 11. Furthermore, the punch 32 is adapted, by moving axially relative to the presser 31 (Figures 12 and 13), to form the flare 22 of the tube 11.

The punch 32 has an active part 33, the outside diameter D6 of which is equal to the required inside diameter D'3 of the collar 21 of the diaphragm 17 when prestressed. This part 33 of the punch 32 is preceded by a centring part 34, the diameter D7 of which is smaller than the diameter D6 of the active part 33. The diameter D7 of the centring part 34 is substantially equal to the inside diameter D3 of the collar 21 before prestressing, itself substantially equal to the inside diameter D4 of the tube 11 before flaring.

For the purpose of assembly by means of the equipment just described, the plate 16 is lined with the diaphragm 17, nesting the collars 21 into the collars 19, then the plate 16 thus lined with the diaphragm 17 is placed on the bezel 30 as illustrated in Figure 8, the presser 31 and the punch 32 being withdrawn opposite the tubes 11 themselves withdrawn.

The presser 31 is brought into abutment with the diaphragm 17 lining the plate 16 (Figure 9) so as to maintain this diaphragm 17 clamped against the plate 16, itself in abutment with the bezel 30.

Then the punch 32 is engaged axially into the collar 21, first of all by the centring part 34 then by the active part 33 so as to prestress the collar 21 (Figure 10). Throughout this operation the presser 31 maintains the diaphragm 17 clamped against the plate 16, itself in abutment with the bezel 30.

The bezel 30 is then withdrawn laterally (Figure 11) and at the same time the centring part 34 of the punch 32 is engaged into the tube 11 (Figure 11).

Then (Figure 12) the prestressed collar 21 is transferred from the active part 33 of the punch 32 onto the tube 11, this operation being effected by an axial move of the presser 31 (Figure 12).

Then (Figure 13) the punch 32 is moved axially so as to engage the active part 33 of the punch 32 into the tube 11 in case it is required to form the

This Page Blank (uspto)

flare 22 (Figure 13).

The assembly is complete. It only remains to withdraw the presser 31 and the punches 32.

It will be appreciated that such an assembly is convenient to perform and readily mechanisable, permitting large series production.

In the embodiment described and illustrated, the tubes 11 have been shown with a circular cross-section, but obviously this cross-section might equally well be oval or have any other appropriate shape.

CLAIMS

1. A method of assembling at least one tube on a plate with the interposition of a seal element; said plate and said seal element each having at least one hole and the hole of said seal element being provided with a collar, wherein one end of said tube is inserted into said collar of said seal element which is itself located in the hole of the plate; said seal element providing fluid-tightness between said tube and said plate, and wherein before inserting said tube, said collar of said seal element is prestressed by subjecting it to a radial reduction of its thickness in abutment with the hole of the plate; the inside diameter of said collar of said seal element being, before prestressing, smaller than the outside diameter of said tube and becoming, after prestressing, sufficiently enlarged to permit insertion of said tube into said collar of said seal element.

2. A method according to Claim 1, wherein after prestressing said collar of said seal element, said collar of said element is transferred onto said tube, thereby maintaining the prestressing.

3. A method according to Claim 1 or Claim 2 wherein the radial reduction in thickness of the collar of said seal element resulting from the prestressing is of the order of 30 to 70%.

4. A method according to Claim 3, wherein the radial reduction in thickness of said collar of said seal element resulting from the prestressing is substantially 50%.

5. A method according to any preceding Claim, wherein said seal element lines the plate opposite the side through which said tube is inserted, and wherein said seal element is clamped against said plate whilst said collar of said seal element is prestressed and/or whilst this prestressed collar is transferred onto said tube.

6. A method according to any preceding Claim, wherein said collar of said seal element is prestressed by engaging axially into said collar of said seal element a punch having an active part of which the outside diameter is equal to the required inside diameter of said collar of said seal element when prestressed.

7. A method according to Claim 6, wherein said punch is engaged into said collar of said seal element through the opposite side to that through which said tube is inserted.

8. A method according to Claim 6 or Claim 7, wherein after said collar of said seal element is prestressed by said punch, and said tube has been inserted into the prestressed collar of said seal element, this same punch is engaged into said tube to form a flare of said tube, the outside diameter of the active part of the punch being equal to the required inside diameter of said tube at the position of the flare.

9. A method according to any of Claims 6 to 8, wherein the active part of the punch is preceded by a centring part having a smaller diameter than the active part.

10. A method according to Claim 9, wherein the diameter of the centring part of said punch is substantially equal to the inside diameter of said collar of said seal element before prestressing.

11. A method according to Claim 9 or Claim 10, wherein the diameter of the centring part of said punch is substantially equal to the inside diameter of said tube before said tube is flared.

12. A method according to any preceding Claim, wherein the hole of said plate is provided with a collar into which said collar of said seal element is itself adapted to nest.

13. Equipment for performing the method according to any preceding Claim, comprising a bezel, adapted to receive in abutment said plate fitted with said seal element, an axially movable presser adapted to maintain the seal element clamped against said plate, which is itself in abutment with the bezel, and a punch fitted axially movably in the presser to prestress said collar of said seal element.

14. Equipment according to Claim 13, wherein the bezel is laterally retractable and the presser is adapted, by thrusting axially on said seal element and said plate, to transfer the prestressed collar of said seal element onto said tube.

15. Equipment according to Claim 13 or Claim 14, wherein the punch is adapted, by moving axially relative to the presser, to flare the tube.

16. A radiator, particularly for a motor vehicle, comprising a plurality of tubes which are provided with fins and at least one end of which is assembled on an end plate of a water chamber; said plate being fitted with at least one seal element which is assembled on said plate by the method according to any of Claims 1 to 12.

17. A radiator, particularly for a motor vehicle, comprising a plurality of tubes which are provided with fins and at least one end of which is assembled on an end plate of a water chamber; said plate being lined with at least one seal element, and wherein each tube is assembled on said plate by means of the equipment according to any of Claims 13 to 15.

18. A method of assembling at least one tube on a plate, substantially as described herein with reference to the accompanying drawings.

Printed for Her Majesty's Stationery Office by the Courier Press, Leamington Spa, 1984. Published by the Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.